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Cost of the Steel Superstructure Of Highway Bridges

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COST OF THE STEEL SUPERSTRUCTURE OF HIGHWAY BRIDGES

BY

WALTER WILLIAM HUFF

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

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WALTER WILLIAM HUFF

ENTITLED COST OF THE STEEL SUPERSTRUCTURE FOR HIGHWAY BRIDGES

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Civil Engineering

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COST OF THE STEEL SUPERSTRUCTURE FOR HIGHWAY BRIDGES.

INTRODUCTION

Cost is the most important factor in all industrial enterprises. It determines the advisability of making new improvements and governs to a great extent the quality and quantity of such improvements. A noted manufacturer once said: "Unless manufacturers study costs carefully they are simply groping in the dark. They may possibly make money, but it is more likely that without a knowledge of what their products are costing them, they will surely run into the hands of a receiver." The American manufacturer to be successful must be an economist, know exact costs, and have the courage to abandon careless and indifferent methods of production. In order to know the exact cost it is necessary for the manufacturer to keep a cost record.

It is essential that bridge companies keep such a record, for the cost items of structural steel production are many and are liable to great variation. Such a record to be of use must be more accurate than any other result demanded in the business administration of a bridge company. If the record is accurate, each day's, week's, or month's performance may be compared with the performance of the day, week, or month previous. An accurate cost system with records of past performances is invaluable to: 1st, the stockholders; 2nd, the management; and 3rd, the engineers. First, it aids the stockholders in deciding whether or not the concern is a paying investment. Second, it aids the management, by constant observation and study of these comparative

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records which show every little detail, to introduce economies, small in themselves but large in the aggregate, by either increasing or decreasing an un-necessarily small or large laboring force, by making new additions to existing buildings, by adding new equipment, and by making the management a systematic and efficient unit. Third, a record of costs is of great value to the engineer of the company and may be used by him to great advantage for bidding or estimating purposes. While a cost record is very valuable to a bridge company, it would also be of value to prospective buyers, engineers and competitors; and it is for this reason that many bridge companies will not part with any information on cost data. In any case it is a rare opportunity for one to obtain such information. Having worked several years for a bridge company, the writer was able to secure, thru the consent of the officials, considerable data on the cost of highway bridges. It is the purpose of this thesis to present and discuss the data thus obtained.

The matter will be considered under the following heads;

I. Method of Cost Keeping.

II. Equipment and Capacity of the Plant.

III. Description of Types of Bridges Considered.

IV. Dimensions, Weight and Cost of Bridges.

a. Leg Bridges.

b. Bedstead and Pony Truss Bridges.

c. Through Pin Connected Pratt Truss " .

I. METHOD OF COST KEEPING

The following system is employed by the business administration of the company; and while perhaps there are companies who keep a more detailed record, the one shown below is certainly sufficient for most, if not all, purposes.

Schedule of Items.

1. Cost of Metal.

a. Raw material.
b. Freight on same to shop.
c. Unloading and storing.

2. Cost of Shopwork.

a. Labor.
b. Heat.
c. Light.
d. Fuel, oil, etc,
e. Electric power.
f. Minor items.

3 Cost of Erection

a. Labor.
b. Haul.
c. Freight on metal to site of bridge.
d. Traveling expenses.
e. Boarding expenses.
f. Minor items: nails, lost tools, telephone, etc.

4. Cost of Incidentals.

a. Office work.
b. Traveling expenses.
c. Drafting, engineer's expenses.
d. Advertising.
e. Salesman labor.
f. Board and lodging.
g. Shop foreman labor.
h. Minor items.

DISCUSSION OF COST ITEMS.

1. Cost of Metal.

The cost of metal per pound has remained practically constant during the last five years. Up to June 1907 the cost per pound f.o.b. Pittsburg had been 1 1/4 cents, but it was changed begining with the date above to 1 1/8 cents f.o.b. Pittsburg. In Table IV column 2, the cost of metal per pound is taken at 2 cents. This amount includes the initial cost, the freight on the metal from the place of purchase to the shop, and the cost of unloading and storing the metal in the receiving yard. This value of 2 cents was determined in the following manner. Each laborer after completing a certain piece of work filled out a time slip showing the date, kind and amount of work, and amount of time expended on it. This method enabled the book-keeper to keep an accurate record of the total amount of time expended in unloading and storing the metal. Knowing each laborer who helped in this work and knowing the wages paid to each, it was then an easy matter to find the total amount of money expended in the unloading and storing of any amount of metal. Having the total cost of a certain amount of metal and also the cost of freight on same from the place of purchase to the shop, by adding the total cost of these two items to the total cost of unloading and storing, and then dividing by the total weight of steel, an average cost per pound of metal was obtained. The difference in price of different shapes of steel is counter-balanced by the

greater or less difficulty encountered in handling the metal. for example, it is more difficult to unload large rolled plates than it is to unload angles, channels, etc;. If a seperate record of the cost per pound of metal, was kept for each different form much confusion would result, and the difference in price between the cost as determined above and this cost listed seperate, would be so small that it would not warrant the keeping of a seperate record for each individual class of work; and it is for that reason a constant value of 2 cents per pound of metal stored in the yard is assumed in all cases.

2. Cost of Shopwork.

There is more care, thought and study given to the selection of the most economical method of shop production than there is to any of the other five items of cost enumerated in the tables. The many details connected with shop work necessitate the need of a well regulated and well organized shop system. The rapidity of turning out the finished product at as low cost as possible, depends upon the shop management, the equipment, the amount of laboring force, and its skill and familarity with the work. In order that each bridge may be turned out as rapidly as possible it is necessary to have a shop system, which has definite methods for putting the iron thru all the processes necessary for the completion of the bridge. Such a system is made possible only thru good shop management which

will in itself increase the earning power of a bridge plant to a great extent. About five years ago this company had no definite shop management and as a result, the shop cost per pound of metal was extraordinarly high. The shop foreman employed at that time was not an experienced bridge man and had no idea how to make the shop an economical one. The officials realizing this employed a shop foreman who had - had coasiderable experience and knew how to run a shop economically. The results have been very satisfactory for within the last three years there has been a marked decrease in the cost of shop production. The amount, skill, and familarity with bridge work of the laboring force of a bridge company are important factors; and it is only thru the employement of the proper amount of skilled workmen, that a bridge plant is made most efficient. With a skilled laboring force, an excellent shop foreman, and good equipment, any bridge plant can be made an excellent paying concern. The labor employed by this company is not union labor and for that reason the shop cost is not as great as it might be provided union labor was employed. Within the last five years there has been a marked increase in the price paid for field and shop labor. The increase in per cent of price paid for various kinds of labor has been

about as follows: machinist 43, riviter 57, helpers 30, blacksmiths 22, drill men 31, "bull gang" or common labor 40, and all others about 25. With such an increase in wages the profit on all bridge work has been reduced somewhat; but this company has counteracted this great increase, by having an organized system, one which has reduced shop cost to an approximate minimum.

3. Cost of Erection

The cost of erection is liable to a great variation and is next to that of the steel, one of the most expensive items of bridge work. Bad weather, high water, bad foundation, and numerous unavoidable accidents tend to vary the cost of erection greatly. Unavoidable delay caused by bad weather or by high water will seriously affect the cost of erection of a small leg or beam bridge because in this case the amount of money lost thru delay is large in proportion to the cost of the bridge. In the case of a large bridge the money lost thru delay is small in proportion to the total weight of the bridge. A great hindrance to an erection foreman and at the same time a factor that causes delay and extra expense, is the poor quality of erection labor employed in most cases or in other words "green helpers". Generally in the erection of small leg bridges the foreman employs two or three helpers from the community where the bridge

is to be erected. Their un-familarity with the work together with their ignorance of the different parts of a bridge, are chief factors in making their services a hindrance to the foreman and an extra expense to the company. In many cases bridge companies will make an estimate of the cost of a bridge without knowing the condition and kind of soil at the bridge site. This negligence on the part of the company sometimes causes them to suffer financial losses. This company suffered a small loss, on the erection of bridge no.3. table IV page , due to the fact that they did not know what kind of material the erector would meet with in excavating for the mud sill. The I beam legs were to rest on a 6"x8" mud sill and four feet of excavation was necessary. When the erector began excavation he struck quicksand and in order to secure a reasonably solid base for the sill, it was necessary for him to drive six 18-foot piles, and in addition to build a concrete base on the top of the piles. The cost of erection had originally been figured at 0.65 cents per pound of metal, but the erection cost 1.11 cents per pound or a total increase of $23.89. While this amount is small it illustrates the need of knowing the condition and kind of material to be excavated before making an estimate. Within the last five years there has been a great increase in the wages paid to bridge erectors and helpers. Five years ago the company paid an erection foreman $2.50 per

day and expenses, and helpers $1.25 to $1.50 per day; while at the present time, a foreman receives $3.00 per day and expenses, an increase of 20%, and helpers are paid $1.75 to $2.25, an increase of 40 to 50%. This increase in price paid to laborers has greatly increased the cost of erection and in some of the bridges enumerated in the tables hereafter, there is a marked difference in the erection cost per pound of metal for bridges of about the same type and span but erected at different times.

4. Cost of Haul.

In most all cases the bridge salesman will contract with some local farmer or teamer in the vicinity of the bridge, to haul the metal to the site of erection. Sometimes the salesman will be able to get the hauling done for a very small price while at other times he will be compelled to pay an exhorbitant price, so that in nearly all cases the cost of haul is a very indefinite quantity. Owing to the difficulty often experienced in being unable to get the metal hauled to the bridge site at the proper time, for a reasonable amount of money, this company purchased their own teams, wagons, etc; and do their own hauling within a radius of fourteen miles. As a result the cost of haul per pound of metal has approached a more constant value; but owing to the uncertain conditions of the weather and roads, and the varying size

of loads, the cost of haul still remains an uncertain quantity.

5 Cost of Freight.

The cost of freight per pound of metal is not liable to any great change. A fixed rate per 100 pounds per mile is offered and no variation is made from this except in cases where a reduced rate is sometimes allowed to a company which does considerable freight business on the particular road allowing the reduction.

6. Cost of Incidentals.

If a small company is running a full force of men the cost of incidentals per pound of metal is small; but if the laboring force is small the cost of incidentals is considerable, owing to the fact that there is more money paid out for labor to the book-keepers, engineers, salesman, shop foreman, and other office help, than there is to the force working in the shops. From a study of item 4, page 4, an idea may be formed of the cost of incidentals, and together with the data given in the tables, no explanation or discussion is necessary.

II. EQUIPMENT AND CAPACITY

No data on the cost of bridges would be of much value unless the equipment and capacity of the shop, the prime factors governing the cost and amount of production, were known. In order to give some idea of the capacity and equipment of the bridge company which turned out the bridges to be considered later in this paper, the writer presents below a list of the principal machines, tools, etc., which shows that the company is well prepared to turn out work as economically as most companies do.

Buildings.

Main building	85 ft × 140 ft — 38 ft high
Blacksmith shop	45 ft × 48 ft — 29 ft high
Templet room	85 ft × 25 ft — 20 ft " .
Paint shed and store room	14 ft × 31 ft — 17 ft " .

Ground Occupied.

1.2 acres for storing finished and painted materials.
1.1 " " buildings and receiving yard.

Equipment.

1 — 16 inch shaper 54 inch reach possible.
1 — 32 — " drill.
1 — 26 — " " .
1 — 13 — " stationary head drill.
1 — 10 — " cylinder air compressor.
1 — 24 — " turret lathe.
1 — 22 — " swing lathe.

1 – 13-inch screw cutting lathe.

1 – No. 8. 30-inch stroke shear – 6-inch by 1-inch capacity. Punch 1" x 1".

1 – Bremmer's No. 4 $\frac{5}{8}$ inch x $\frac{5}{8}$ inch punch.

4 – 8-inch saws.

1 – Compressed air tank, 4 ft x 12 ft.

1 – 10-inch Allen long stroke air compression lever machine for riveting.

1 – 8-inch by 1-inch Boyer long-stroke hammer.

1 – 8-inch by 1-inch Cleveland " " " .

1 – Oil burning furnace, two openings, taking oil by gravity from a storage tank of 7500 gallons capacity.

1 set Bertsch rolls, 72 inches between housings, run by a 10 H.P. electric motor.

4 Forges, air furnished by a No. 6 Buffalo Champion fan operated by a 5 H.P. motor.

1 2½ inch bolt cutter.

1 Portable beam cutting shears, 10 inch capacity.

1 30-inch rotary planer.

1 No 3 Boyer piston air drill or reamer.

2 Independent electric motors, 5 and 10 H.P. respectively.

1 30 H.P. motor.

3 Trolley lines over-head.

1 Traveler 10-ton capacity.

1 90-ft Gantry for unloading material.

2 Jib cranes.

5 Swinging cranes.

8 Hennyton screw hoists, ½ to 3 tons capacity.

Numerous other small machinery and tools.
495 ft of service tracks.
8 service cars

Capacity.

When the bridge plant is in full operation about 32 men are employed in the shop. The greatest amount of work turned out by the plant within the last five years was 2200 tons per annum, however the capacity could be placed at 3000 tons per annum.

III. DESCRIPTION OF TYPES OF BRIDGES CONSIDERED.

For comparative purposes bridges of different type, span and period of construction were chosen from a number of bridges completed by the company within the last five years. The bridges vary in size from a small leg bridge of 8-foot span up to a through pin-connected Pratt truss of 140-foot span. The bridges are divided into three general classes, namely, leg, bedstead and pony truss, and high truss bridges.

The most common form of a county highway bridge is the leg bridge. As there are a greater number of small streams and depressions to be bridged, than there are large ones, and as the leg or beam bridge is an economical and substantial one for small spans,

it follows at once that they should be in greater demand and more of them built than any other class of bridge.

The main parts of a common leg bridge are the floor joists, I-beam legs or columns, angles to brace the columns, and a small hand rail fastened to the channel joists by either bolts or rivets. This hand rail may consist either of two angles fastened to angle posts in turn fastened to the channel joists, or of two angles laced. There are two kinds of lattice rail: first, the square cornered, and second, the round cornered.

Formerly the company made round cornered lattice rail leg bridges, but have ceased to make them owing to the fact that this type is not economical and as a rule makes no better appearance than the square cornered style. The legs are fastened to the mud sill by spikes and angle lugs.

The leg bridge seems so simple in make up that no thought or care of its construction and erection are deemed necessary; but such is not the case, for in order to turn this kind of bridge out at as low a cost as possible requires a great deal of careful consideration as to the most efficient and economical method to be employed in its manufacture and erection. The six tables given hereafter, show data pertaining to the cost of leg bridges and are self explanatory. The bridges are arranged so that those of the same span

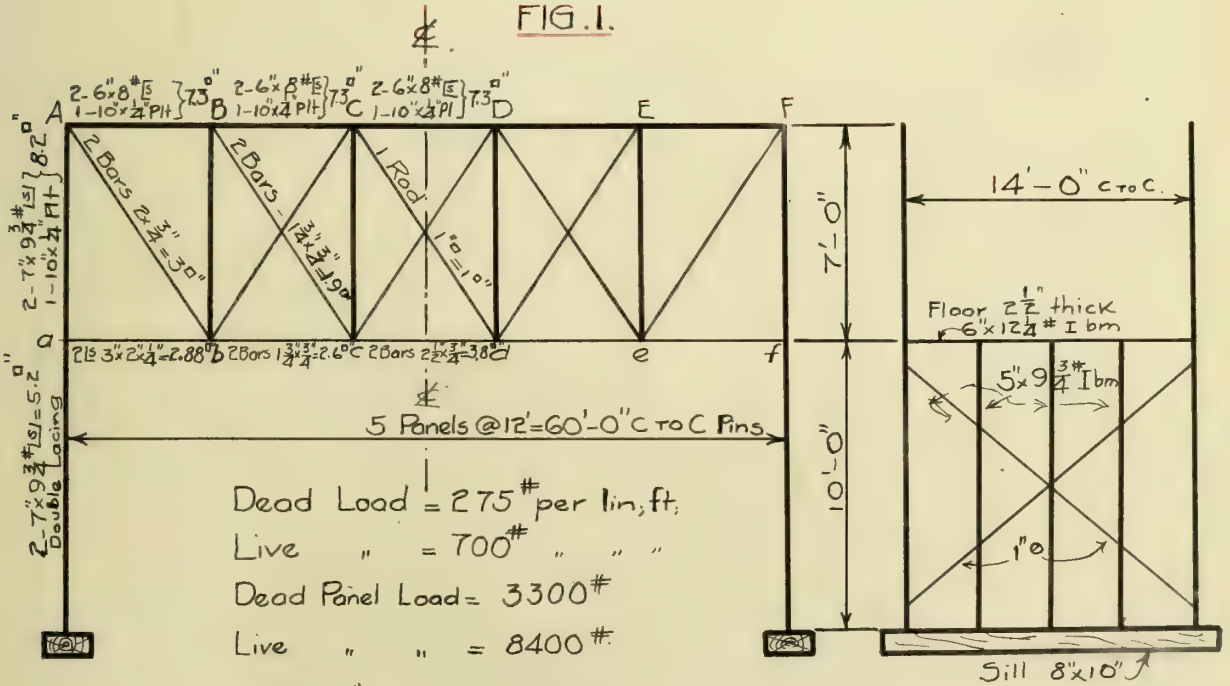
are placed together. This offers a better opportunity for comparing the cost of the same kind and size of bridge. No attempt will be made to give the exact conditions under which each bridge was built and erected, as this would be impossible.

BEDSTEAD BRIDGES.

There are two forms of the bedstead truss, the pin-connected and the rivited-connected. Fig 1. and 2 show the standard plans for these two forms, and also give the composition of the several members.

Pin-Connected Bedstead.

FIG. 1.



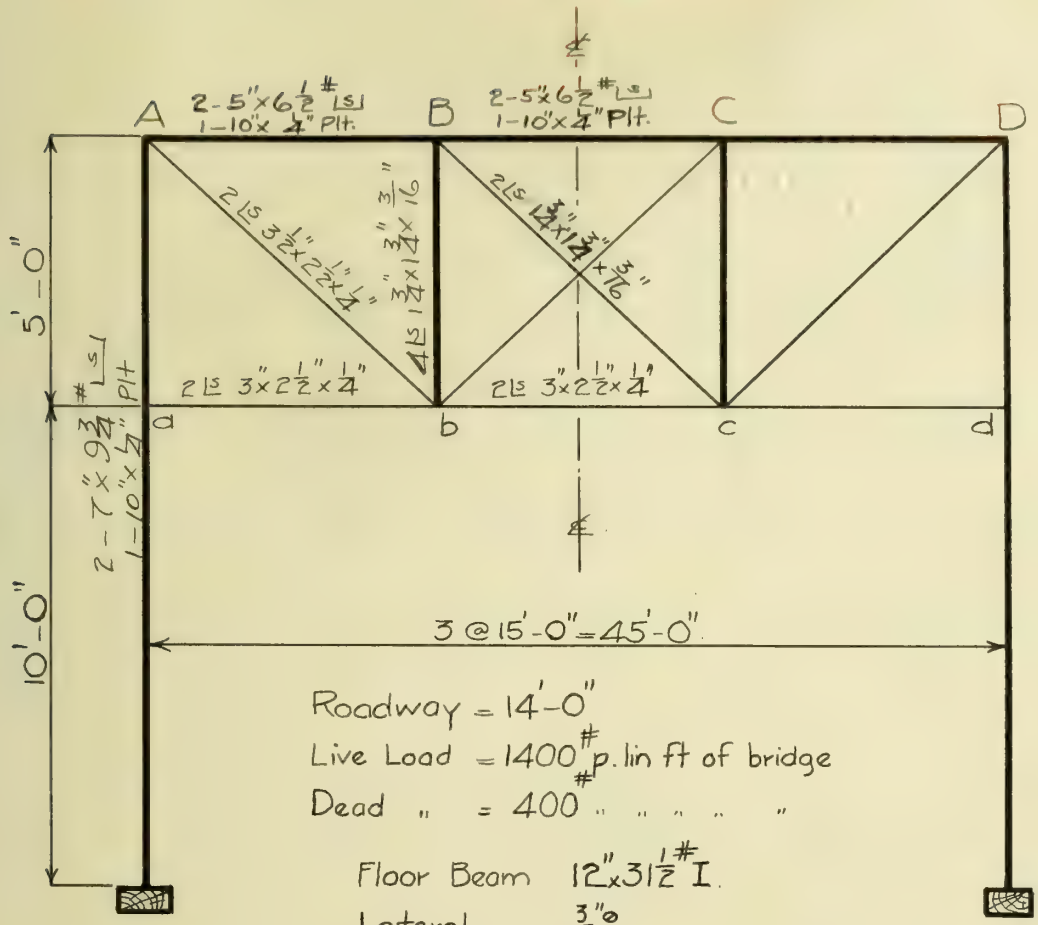
Dead Load = 275# per lin. ft.
Live " = 700# " " "
Dead Panel Load = 3300#
Live " " = 8400#

Joice	5-5"x9¾# I's and 2-5"x6½#[S].
Floor Beam	12"x31.5# I Bm.
Pins	3" Dia
Laterals	1", ⅞" and ¾" ø.

Weight of Truss =	10620#
" " Beam =	2016#
" " Joice =	3761#
TOTAL =	16397#

Rivited-Connected Bedstead

FIG. 2.



Roadway = 14'-0"

Live Load = 1400# p. lin ft of bridge

Dead " = 400 " " " " "

Floor Beam 12"×31½# I.

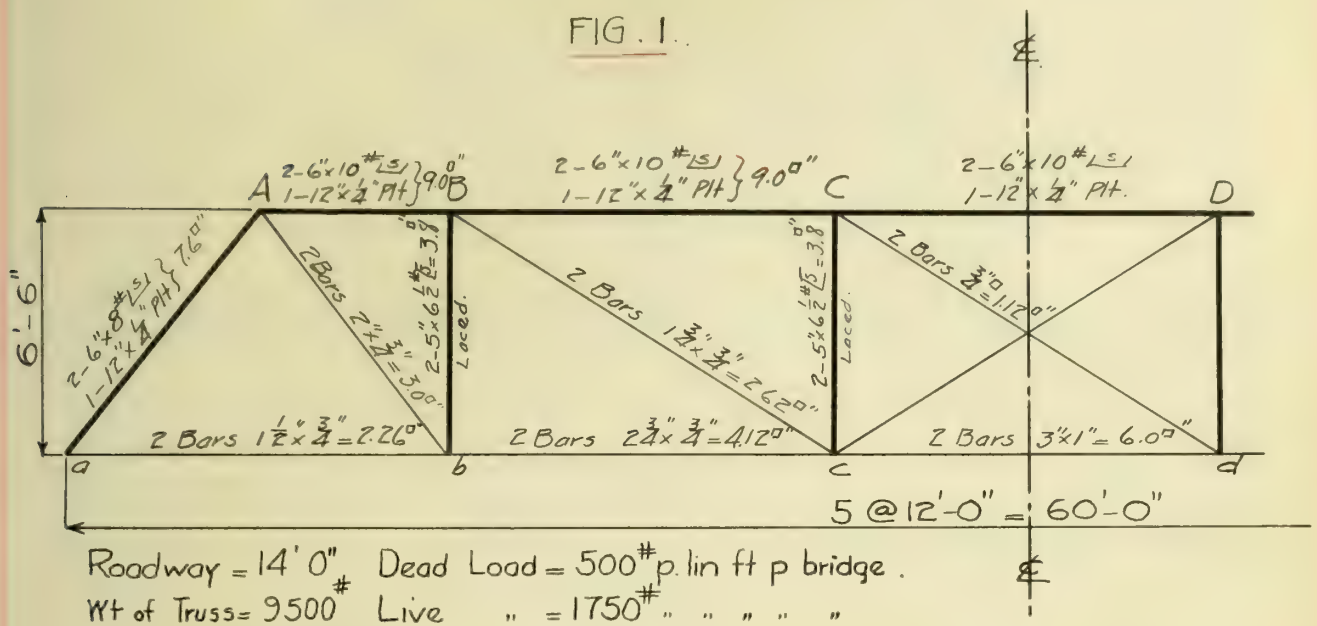
Lateral ¾"ø

Weight 8263 lbs.

PONY TRUSS BRIDGES.

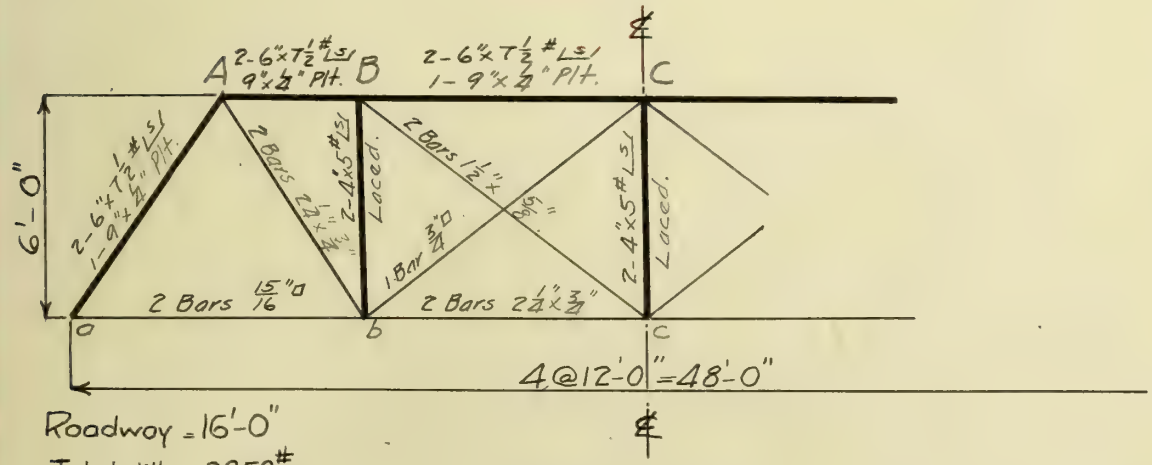
Figures 1 and 2 shown below are common forms of a Pony-Truss bridge.

FIG. 1.



Roadway = 14' 0" Dead Load = 500# p. lin ft p bridge.
Wt of Truss = 9500# Live " = 1750# " " " " "
" " Beams = 2050# Laterals = 7/8" and 3/4".
" " Joist = 3840# Floor Beam = 12"x32# I
TOTAL = 15390# Joist = 5-5"x10# I's and 2-5"x6 1/2# LS.

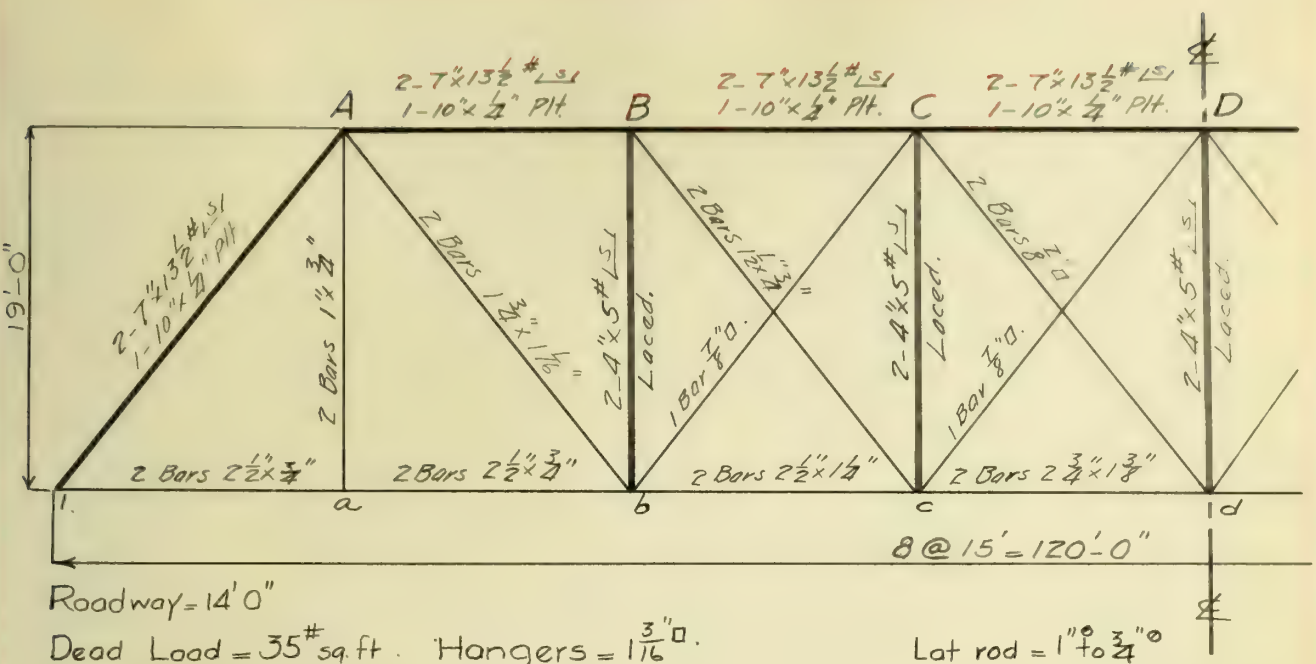
FIG. 2.



Roadway = 16'-0"
Total Wt = 8958#
Dead Load = 25# p. sq. ft.
Live " = 100# " " "
Laterals = 3/4"
Beams = 12"-35# I's
Pins = 2" to 2 1/2"

Hangers = 1 1/8" Bars.
Joist = 6-6"x12 1/4# I's and 2-6"x8# LS.

THRU PIN-CONNECTED PRATT TRUSS



Roadway = 14'0"

Dead Load = 35# sq. ft. Hangers = 1 3/16"□. Lat rod = 1"⊙ to ¾"⊙

Live " = 100# " " Portals = 2-2"×2"×¼" ⌊s Laced — Wt of metal = 28381#

Pins = 2 5/8" to 3 3/8" Lat Struts = 1¾"×1¼"×3/16" ⌊s "

IV. DIMENSIONS, WEIGHT and COST of BRIDGES.

TABLE I.

GENERAL DATA FOR LEG BRIDGES

Ref No.	Span.	Roadway.	Height of Truss.	Length of Legs.	Kind of Backing.
1.	26' 0"	16' 0"	3' 9"	———	Concrete.
2.	26' 0"	14' 0"	3' 9"	———	"
3.	26' 0"	16' 0"	4' 0"	———	"
4.	26' 0"	14' 0"	3' 10"	8' 0"	Wood.
5.	25' 0"	14' 0"	2' 10"	8' 6"	"
6.	24' 0"	14' 0"	3' 9"	7' 0"	"
7.	24' 0"	14' 0"	3' 7"	12' 0"	"
8.	24' 0"	16' 0"	3' 8"	6' 0"	"
9.	16' 0"	14' 0"	2' 9"	7' 0"	Concrete.
10.	14' 0"	14' 0"	3' 6"	7' 6"	Wood.
11.	14' 0"	14' 0"	3' 6"	14' 0"	Steel.
12.	10' 0"	12' 0"	2' 9"	7' 0"	Wood.
13.	10' 0"	14' 0"	2' 9"	12' 0"	"
14.	8' 0"	14' 0"	2' 6"	8' 0"	"
15.	50' 0"	4' 0"	3' 0"	———	"

TABLE II.

YYEIGHT OF LEG BRIDGES

Ref No.	Joists	Legs	Trusses	Backing	Other Parts Of Bridge	Total Pounds.
1	3276	—	1094	—	374	4744
2	2730	—	1094	—	476	4300
3	3276	—	1487	—	426	5189
4	2730	1369	1454	—	310	5863
5	2170	1235	1245	—	364	5019
6	2179	1199	1108	—	278	4764
7	2160	1418	872	—	474	5424
8	2592	770	1023	—	348	4733
9	1440	950	550	—	283	3123
10	827	744	405	—	258	2234
11	827	1488	405	2748	384	5852
12	900	735	519	—	300	2454
13	900	1982	519	—	270	3671
14	720	1135	415	—	175	2445
15	—	—	—	—	—	2625

TABLE III.

COST OF LEG BRIDGES.

Ref No.	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total $
1	94.88	45.00	12.50	9.95	8.70	15.00	186.03
2	86.00	39.50	10.60	4.65	12.50	15.00	168.25
3	103.78	58.00	16.30	13.60	11.80	25.00	228.48
4	117.26	31.24	14.50	10.00	19.60	20.00	212.60
5	100.38	23.45	9.21	8.00	4.90	15.00	160.94
6	95.28	18.33	14.00	10.00	9.63	20.00	167.24
7	108.48	21.25	18.35	14.00	17.48	25.00	194.56
8	94.66	25.00	6.71	15.00	6.02	10.00	157.39
9	62.46	27.15	14.85	6.00	5.53	14.00	129.99
10	44.68	21.03	3.50	9.00	2.49	3.00	83.70
11	117.04	44.19	9.42	8.00	14.18	20.00	212.83
12	49.08	17.50	5.28	4.50	7.65	6.00	90.01
13	73.42	23.60	11.00	6.00	5.10	15.00	134.12
14	48.90	15.00	3.78	10.00	7.00	8.00	92.68
15	52.50	10.95	10.52	3.00	13.90	6.00	96.87

TABLE IV.

COST OF LEG BRIDGES PER POUND OF METAL.

Ref No	Metal ¢	Erection ¢	Shop ¢	Haul ¢	Freight ¢	Incidentals ¢	Total ¢
1	2.00	0.95	0.26	0.21	0.18	0.31	3.91
2	2.00	0.92	0.25	0.11	0.30	0.35	3.93
3	2.00	1.11	0.31	0.26	0.22	0.48	4.38
4	2.00	0.53	0.24	0.17	0.33	0.34	3.61
5	2.00	0.47	0.18	0.15	0.10	0.30	3.20
6	2.00	0.39	0.30	0.21	0.20	0.42	3.52
7	2.00	0.40	0.33	0.25	0.32	0.46	3.76
8	2.00	0.53	0.14	0.31	0.12	0.21	3.31
9	2.00	0.87	0.48	0.19	0.18	0.45	4.17
10	2.00	0.94	0.15	0.40	0.11	0.13	3.73
11	2.00	0.75	0.16	0.13	0.24	0.34	3.62
12	2.00	0.71	0.22	0.18	0.31	0.24	3.66
13	2.00	0.64	0.30	0.16	0.14	0.41	3.65
14	2.00	0.61	0.15	0.41	0.29	0.32	3.78
15	2.00	0.41	0.40	0.11	0.50	0.23	3.65
AVERAGE	2.00	0.68	0.26	0.22	0.23	0.33	3.72

TABLE V.

COST OF LEG BRIDGES PER LINEAR FOOT OF SPAN.

Ref No.	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total $
1	3.60	1.73	0.48	0.38	0.33	0.58	7.16
2	3.31	1.52	0.41	0.18	0.48	0.58	6.47
3	4.00	2.23	0.63	0.52	0.45	0.96	8.79
4	4.51	1.20	0.56	0.38	0.75	0.77	8.18
5	4.01	0.94	0.37	0.32	0.20	0.60	6.44
6	3.97	0.76	0.58	0.42	0.40	0.85	6.97
7	4.52	0.89	0.76	0.58	0.73	1.04	8.11
8	3.53	1.04	0.28	0.62	0.25	0.41	6.56
9	3.90	1.70	0.93	0.38	0.34	0.88	8.12
10	3.19	1.50	0.25	0.64	0.18	0.21	5.98
11	8.36	3.15	0.67	0.57	1.01	1.43	15.20
12	4.91	1.75	0.53	0.45	0.77	0.60	9.00
13	7.34	2.36	1.10	0.60	0.51	1.50	13.41
14	6.11	1.87	0.47	1.25	0.87	1.00	11.58
15	1.05	0.22	0.21	0.06	0.28	0.12	1.94
AVERAGE	4.42	1.52	0.55	0.49	0.50	0.77	8.25

TABLE VI.

GENERAL DATA FOR BEDSTEAD AND PONY TRUSS BRIDGES.

Ref No.	Type of Bridge.	Span.	Roadway.	Height of Truss.	Length of Approach.	Kind of Backing.
1	Rivited Bedstead.	24' 0"	14' 0"	5' 0"	50' 0"	Concrete
2	" "	24' 0"	12' 0"	5' 0"		Wood
3	Pin-Connected Pony.	30' 0"	14' 0"	6' 0"	—	Concrete
4	" " Bedstead.	30' 0"	12' 0"	5' 0"	—	"
5	" " "	32' 0"	14' 0"	5' 0"	—	Wood
6	Rivited I Beam "	32' 0"	14' 0"	5' 6"	—	Steel
7	" " " "	32' 0"	14' 0"	5' 6"	—	"
8	Pin-Connected "	36' 0"	12' 0"	5' 0"	—	Concrete
9	" " "	36' 0"	14' 0"	5' 0"	—	Wood
10	" " "	36' 0"	14' 0"	5' 0"	20' 0"	"
11	Rivited I-Beam "	36' 0"	12' 0"	5' 0"	—	"
12	Pin-Connected "	40' 0".	14' 0"	5' 6"	—	"
13	Rivited "	40' 0"	14' 0"	6' 0"		"
14	Pin-Connected "	42' 0"	12' 0"	5' 0"	—	"
15	Rivited "	45' 0"	14' 0"	5' 6"	—	—
16	" "	45' 0"	14' 0"	6' 0"	—	Steel
17	Pin-Connected Pony	45' 0"	14' 0"	6' 0"	—	Wood
18	Rivited Bedstead.	45' 0"	14' 0"	5' 6"	—	"
19	Pin-Connected "	56' 0"	12' 0"	6' 6"		"
20	" " Pony	56' 0"	12' 0"	7' 0"	—	"
21	" " Bedstead.	60' 0"	12' 0"	7' 6"	—	Concrete
22	" " "	60' 0"	14' 0"	6' 9"	—	Steel

TABLE VII.

WEIGHT OF BEDSTEAD AND PONY TRUSS BRIDGES.

Ref No.	Joists.	Legs.	Steel Tubes.	Steel Backing.	Weight of Bridge Exclusive of Joists, Legs, Tubes, and Backing	Total Pounds.
1	1462	4625	—	—	4477	10564
2	1473	1356	—	—	4000	6829
3	1838	—	—	—	3533	5593
4	1845	1780	—	—	4801	8426
5	2411	585	—	—	6296	9292
6	2455	646	—	4053	2509	10143
7	2455	1126	—	4053	2509	10143
8	1917	—	—	—	8457	10374
9	2210	—	—	—	8340	10550
10	3457	1016	—	—	8520	12993
11	1917	590	—	—	8831	11338
12	3149	450	—	—	7635	11234
13	2530	880	—	—	6089	9499
14	3066	—	—	—	8995	12061
15	2216	1076	—	—	6670	9962
16	2580	662	—	2960	8378	14580
17	2220	670	—	—	6940	9830
18	2216	1076	—	—	6670	9962
19	4187	—	—	—	6590	10777
20	4187	—	—	—	5981	10168
21	4652	—	5060	—	9241	18953
22.	4620	646	—	2662	11509	19437

TABLE VIII.

COST OF BEDSTEAD AND PONY TRUSS BRIDGES

Ref No.	Metal $	Erection $	Shop $	Haul. $	Freight $	Incidentals $	Total $.
1	211.28	130.07	43.04	15.00	30.00	25.00	454.39
2	136.58	97.74	36.85	24.80	12.90	25.00	333.87
3	111.86	66.40	40.70	6.00	17.82	20.00	262.78
4	168.52	100.00	44.99	16.50	16.33	25.00	371.34
5	185.84	43.11	32.70	10.00	26.00	20.00	317.65
6	202.86	55.00	47.95	5.00	27.43	47.50	385.74
7	202.86	60.00	47.95	15.00	27.43	47.50	400.74
8	207.48	95.00	61.61	37.00	32.84	66.96	500.89
9	211.00	97.00	59.40	31.00	40.66	56.40	495.46
10	259.96	72.00	57.24	25.00	17.00	25.00	456.20
11	226.76	77.00	55.13	15.00	26.26	30.00	430.15
12	224.68	56.00	79.50	20.00	37.90	20.00	438.08
13	189.98	66.44	44.21	10.00	16.64	25.00	352.27
14	241.22	85.00	71.00	15.00	26.00	85.00	523.22
15	199.24	80.00	53.52	30.00	14.30	58.00	435.06
16	284.31	72.37	50.48	25.00	39.00	67.50	538.66
17	196.60	63.80	46.47	12.00	23.60	45.00	387.47
18	199.24	85.00	53.52	25.00	14.30	61.00	438.06
19	215.54	59.60	50.85	15.00	33.60	53.80	428.39
20	202.36	92.50	69.84	10.00	20.10	50.00	444.80
21	379.06	89.00	115.50	40.00	40.30	110.00	773.86
22	388.74	168.66	69.73	32.00	16.16	45.00	720.29

TABLE IX.

COST PER POUND OF BEDSTEAD AND PONY TRUSS BRIDGES.

Ref No.	Metal ¢	Erection ¢	Shop ¢	Haul ¢	Freight ¢	Incidentals ¢	Total ¢
1	2.00	1.23	0.41	0.14	0.28	0.24	4.30
2	2.00	1.43	0.54	0.36	0.19	0.37	4.89
3	2.00	1.19	0.73	0.11	0.32	0.36	4.70
4	2.00	1.19	0.53	0.20	0.19	0.30	4.41
5	2.00	0.46	0.35	0.11	0.28	0.22	3.42
6	2.00	0.54	0.47	0.05	0.27	0.47	3.80
7	2.00	0.59	0.47	0.15	0.27	0.47	3.95
8	2.00	0.92	0.59	0.36	0.32	0.65	4.82
9	2.00	0.92	0.56	0.29	0.39	0.53	4.69
10	2.00	0.55	0.44	0.19	0.13	0.19	3.51
11	2.00	0.68	0.49	0.13	0.23	0.26	3.79
12	2.00	0.50	0.71	0.18	0.34	0.18	3.90
13	2.00	0.70	0.47	0.11	0.18	0.26	3.71
14	2.00	0.70	0.59	0.12	0.22	0.70	4.34
15	2.00	0.80	0.54	0.30	0.14	0.58	4.37
16	2.00	0.50	0.35	0.17	0.27	0.46	3.74
17	2.00	0.65	0.47	0.12	0.24	0.46	3.94
18	2.00	0.85	0.54	0.25	0.14	0.61	4.40
19	2.00	0.55	0.47	0.14	0.31	0.50	3.98
20	2.00	0.91	0.69	0.10	0.20	0.49	4.38
21	2.00	0.47	0.61	0.21	0.21	0.58	4.08
22	2.00	0.87	0.36	0.16	0.08	0.23	3.70

TABLE X

COST OF BEDSTEAD AND PONY TRUSS BRIDGES PER LINEAR FOOT OF SPAN.

Ref No.	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total $
1	8.81	5.42	1.79	0.63	1.25	1.04	18.94
2	5.69	4.07	1.54	1.03	0.54	1.04	13.91
3	3.73	2.21	1.36	0.20	0.59	0.67	8.76
4	5.62	3.33	1.50	0.55	0.54	0.83	12.38
5	5.81	1.35	1.02	0.31	0.81	0.62	9.92
6	6.34	1.72	1.50	0.15	0.86	1.50	12.06
7	6.34	1.88	1.50	0.47	0.86	1.50	12.52
8	5.76	2.64	1.71	1.02	0.91	1.86	13.91
9	5.86	2.69	1.65	0.86	1.13	1.57	13.76
10	7.22	2.00	1.60	0.70	0.47	0.70	12.67
11	6.30	2.14	1.53	0.42	0.73	0.83	11.95
12	5.62.	1.40	1.99	0.50	0.95	0.50	10.95
13	4.75	1.66	1.11	0.25	0.42	0.63	8.80
14	5.74	2.02	1,70	0.36	0.62	2.02	12.46
15	4.43	1.78	1.19	0.67	0.32	1.30	9.66
16	6.32	1.61	1.12	0.55	0.87	1.50	12.46
17	4.37	1.42	1.03	0.27	0.52	1.00	8.61
18	4.43	1.89	1.19	0.55	0.32	1.35	9.73
19	3.85	1.06	0.91	0.27	0.60	0.96	7.65
20	3.61	1.65	1.24	0.18	0.36	0.90	7.94
21	6.32	1.48	1.92	0.67	0.66	1.83	12.90
22	6.48	2.81	1.16	0.53	0.27	0.75	12.00

TABLE XI.

AVERAGE COST PER POUND OF 22 BEDSTEAD AND PONY TRUSS BRIDGES.

Ref No	Metal ¢	Erection ¢	Shop ¢	Haul. ¢	Freight ¢	Incidentals ¢	Total ¢
1-22	2.00	0.78	0.51	0.18	0.24	0.41	4.12

TABLE XII.

AVERAGE COST PER LINEAR FOOT OF SPAN OF 22 BEDSTEAD AND PONY TRUSS BRIDGES.

Ref No	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total. $
1-22	5.60	2.19	1.42	0.50	0.67	1.13	11.51

TABLE XIII

GENERAL DATA FOR THROUGH PIN-CONNECTED PRATT TRUSS BRIDGES.

Ref No	No. Of Panels	Span.	Roadway.	Height of Truss.	Length of Approach.	Kind Of Backing
1	5	82' 0"	14' 0"	17' 0"		Wood
2	"	85' 0"	14' 0"	16' 0"		"
3	6	100' 0"	14' 0"	18' 0"	20' 0"	Concrete
4	"	100' 0"	14' 0"	18' 0"	—	"
5	"	100' 0"	14' 0"	18' 0"	30' 0"	Wood
6	7	120' 0"	14' 0"	20' 0"	—	Concrete
7	8	140' 0"	14' 0"	24' 0"	—	"

TABLE XIV.

WEIGHT OF THROUGH PIN-CONNECTED PRATT TRUSS BRIDGES.

Ref No.	Joists	Legs	Tubes.	Backing	Weight of Other Parts Of Bridge.	Total.
1	6270	4000	7000	—	18733	36003
2	6536	2560	—	-	15152	24248
3	7030	1300	4284	—	26820	39434
4	7030	—	—	—	33594	40624
5	9030	1900	4284	—	23231	38445
6	14374	2000	11593	—	36086	64053
7.	—	—	—	—	—	59206.

TABLE XV

COST OF THROUGH PIN CONNECTED PRATT TRUSS BRIDGES

Ref No.	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total $
1	720.06	185.10	170.25	25.75	58.90	75.00	1234.56
2	484.96	176.80	117.69	32.93	12.00	48.50	972.88
3	788.68	419.22	207.60	55.00	31.33	56.97	1558.80
4	812.48	377.48	223.20	38.00	157.07	92.50	1700.73
5	768.90	200.60	193.13	40.00	73.60	62.00	1338.23
6	1281.06	537.73	351.39	28.50	190.11	100.00	2488.79
7	1184.12	517.67	335.00	60.00	75.50	185.00	2357.29

TABLE XVI.

COST PER POUND OF METAL OF THROUGH PIN-CONNECTED PRATT TRUSS BRIDGES.

Ref No.	Metal ¢	Erection ¢	Shop ¢	Haul ¢	Freight ¢	Incidentals ¢	Total. ¢
1	2.00	0.52	0.47	0.07	0.16	0.21	3.43
2	2.00	0.73	0.49	0.14	0.05	0.20	3.61
3	2.00	1.06	0.52	0.11	0.08	0.14	3.91
4	2.00	0.93	0.55	0.09	0.39	0.22	4.18
5	2.00	0.52	0.50	0.10	0.19	0.16	3.47
6	2.00	0.84	0.55	0.04	0.30	0.15	3.88
7	2.00	0.87	0.56	0.10	0.13	0.31	3.97
AVERAGE	2.00	0.78	0.52	0.09	0.19	0.20	3.78

TABLE XVII.

COST PER LINEAR FOOT OF SPAN OF THROUGH PIN-CONNECTED PRATT TRUSS BRIDGES.

Ref No.	Metal $	Erection $	Shop $	Haul $	Freight $	Incidentals $	Total. $.
1	8.78	2.25	2.07	0.31	0.72	0.91	15.04
2	5.71	2.08	1.38	0.39	0.14	0.57	10.27
3	6.57	3.50	1.73	0.46	0.26	0.47	12.99
4	8.12	3.77	2.23	0.38	1.57	0.93	17.00
5	5.91	1.54	1.49	0.31	0.57	0.47	10.29
6	10.67	4.48	2.93	0.23	1.59	0.83	20.73
7	8.45	3.70	2.40	0.43	0.54	1.32	16.84
AVERAGE	7.74	3.04	2.03	0.36	0.77	0.79	14.73

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